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Abstract

EXPERIENCE IN RELATING THE OBSERVED THERMAL PERFORMANCE OF CIVIL MAGNOX-URANIUM POWER REACTORS TO DESIGN PREDICTIONS AND OPERATING CRITERIA

by

* P.R.J. French
\+ D.J. Millard
* M.J. Cartmell
* B.K. Chesterton

1. The paper is based on experience gained from the operation of the nuclear power stations at Berkeley, Bradwell, and Latina, and is concerned with the relationships between the power output of the reactors, the distributions over the reactor core of gas temperature and fuel element temperature, and the temperature limitations adopted in design and operation.

2. The derivation of the temperature limitations that governed the initial design of the reactors is outlined, and the instrumental facilities that are available for checking that these limitations are met during operation are summarised. It is shown that the measurements of fuel element temperature and fuel channel gas outlet temperature are made on the basis of sampling the actual distributions over the very large numbers of elements and channels.

3. During the early operation of the stations, the gas outlet temperature and the power output were restricted by criteria which

* The Nuclear Power Group, Knutsford
\+ Central Electricity Generating Board, Berkeley Power Station

were based on the predicted behaviour of the reactors under fault conditions. The paper explains the derivation of these criteria, and of a rapid approximate method of temperature assessment which enabled the fault criteria to be translated into simple Operating Rules concerning the maximum permitted values of the indicated gas and fuel element temperatures. Technical progress has since enabled the operating restrictions to be relaxed, so enabling all the stations to be operated at design output or above. The main contributions towards this relaxation have been the satisfactory experience of early operation, improvements to the protective equipment of the reactors, out-of-pile research into the behaviour of the fuel elements under fault conditions, and improvements in the techniques used for the statistical analysis of the operational temperature measurements.

4. A description is given of a method of analysing the operational temperature measurements which has been programmed for a digital computer, and has been found to be convenient and effective in practice. The method yields print-outs in the form of core plans showing the inferred systematic distributions, channel by channel, of fuel element temperature and channel gas outlet temperature, under both steady-state and fault transient conditions. The analysis also determines the standard deviations of fuel element temperature and gas temperature, so that estimates of the random maximum temperatures under normal and fault conditions can be made.

5. Methods available for the prediction of temperature distributions for given operating conditions are outlined, and predictions made by these methods are compared with observations at the three stations.

6. A table is included to show the comparison between the design power output and temperatures, the conditions existing during early operation and more recent conditions at all the stations.